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EDITORIAL

What's new: the Glasgow Coma Scale at 50—evolution and future directions

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Fifty years ago, Graham Teasdale and Bryan Jennett introduced the Glasgow Coma Scale (GCS, https://www.glasgowcomascale.org), a groundbreaking tool for the assessment of coma and impaired consciousness in patients with traumatic brain injury (TBI) [1]. The GCS provided an objective and standardized framework for evaluating a patient's level of consciousness by assessing eye-opening, verbal response, and motor responses, each scored within specific categories. Before its introduction, the consciousness levels were often described in vague terms such as "*comatose*" or "*stuporous*", leading to inconsistent communication among healthcare providers and delays in detecting clinical changes.

Since its introduction, the GCS has been rapidly adopted into clinical practice worldwide. Its initial use in acute TBI has expanded to general clinical practice for any patient at risk of impaired consciousness. Its ease of use after a short period of training means that the GCS, and the GCS sum score derived from the individual components, have been incorporated into numerous classification and triage systems globally, including in low resource settings [2]. The "common language" and structure of assessment of patients using the GCS has helped transform acute TBI care and research.

Although the GCS sum score has been shown to correlate with patient outcome, any individual sum score can be derived from different combinations of the three components of the GCS, each with varying prognostic value [3]. In fact, no individual clinical or patient feature has the granularity to capture the full spectrum of TBI severity [4]. The GCS motor component, age, pupillary reactivity, and CT characteristics are the individual features that carry most information for estimation of a patient's likely outcome [5].

The original description of the GCS focused on the broad assessment of consciousness and was used soon after to define a cohort of patients with severe TBI (inability to obey commands, utter recognizable words or to open the eyes) [6]. It was not until 1981 when GCS 13 to 15 was first used to define "minor" as it was then stated or "mild" now TBI [7] and 1982 when GCS 9 to 12 was formally separated as a distinct group and labelled as "moderate" TBI [8]. In the later paper, it was observed that the outcome predictors in the moderate group were more similar to patients with a GCS < 8 (length of coma, CT diagnosis, GCS on discharge) compared to those who had GCS > 12 (age, education, socio-economic status) [8]. However, such categorization of the severity of TBI based on the sum score into mild, moderate or severe is an oversimplification for many patients, even if widely used. There is mounting evidence of the long-term adverse sequelae after TBI no matter the initial severity [9]. For example, those who present GCS 15, but who develop post-traumatic amnesia immediately after ictus(10) or those who in the longer-term have persisting post-concussion symptoms [9]. There are also a subset of patients where outcome is incongruent with initial GCS e.g. those who present while intoxicated [11].

The assessment of TBI severity and estimation of a patient's likely outcome therefore benefits from strategies that incorporate features additional to GCS. The prognostic models in patients with TBI that incorporate multi-variate features include more complex models such as the IMPACT calculator (http://www.tbi-impact.org/?p=impact/calc), the Full Outline of UnResponsiveness score (FOUR) which takes into account brainstem and respiratory signs, [12] and simpler approaches, for example, the GCS-pupils age CT charts (https://www.glasgowcomascale.org/gcs-pa-charts/). While simpler

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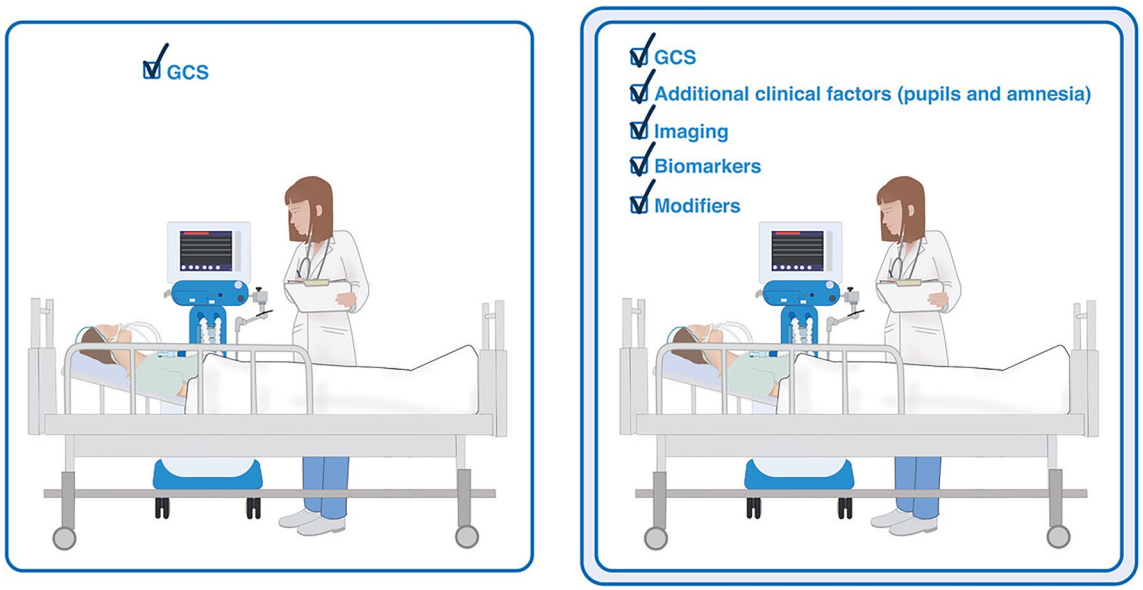

Fig. 1 This figure illustrates the evolution of TBI assessment, from the traditional Glasgow Coma Scale to a proposed multidimensional framework aimed at improving prognostication and personalized care. In the left panel, the GCS is depicted as the sole method for assessing consciousness. The right panel showcases a more comprehensive model for TBI assessment, which builds upon the GCS by integrating additional clinical factors, imaging, biomarkers, and patient-specific modifiers. This enhanced framework aims to overcome the limitations of the GCS sum score alone, addressing the need for a more granular and personalized evaluation of TBI, as recommended by recent research and the NIH-NINDS initiative

approaches are designed to be more readily understood and adopted into clinical practice they often lose information in the estimation of the outcome they make compared to more complex models.

As our understanding of TBI pathophysiology has evolved, the medical community has advocated for a more comprehensive approach to the assessment of TBI severity. In addition to more comprehensive clinical and imaging features incorporated into existing models, new approaches might integrate additional clinical and biological data. Ensuring standardization of such blood-based biomarkers and advanced imaging techniques will be important albeit challenging, particularly in resource-limited environments. The overall aim would be to provide a more accurate and individualized characterization of a patient's condition, and their likely outcome, but prospective studies will be required to establish how these new models perform in comparison to existing approaches. As new technologies come online and knowledge of what leads to different outcome trajectories becomes more refined, characterization protocols will need to be continually updated, adding to the complexity of adoption into clinical practice.

Congruent with the above identified needs the US National Institutes of Health–National Institute of Neurological Disorders and Stroke (NIH-NINDS) launched an international consensus initiative in 2023 regarding a new approach to assessment (https://www.ninds.nih.gov/news-events/events/ninds-tbi-classification-and-nomenclature-workshop). This initiative aims to develop a new framework for TBI characterization and nomenclature. The proposed multidimensional framework includes the GCS and pupillary reactivity as clinical cornerstones, as well as imaging characteristics, some of which are found in the GCS-Pupils age CT prognostic charts [13]. In addition, the framework will seek to incorporate information from blood-based biomarkers, and various modifiers such as patient-specific factors [11]. The new multidimensional framework proposed by the NIH-NINDS initiative is designed to provide a more comprehensive and actionable description of TBI [14]. Whether it achieves these aims will require to be established in large, prospective studies.

One of the great strengths of the GCS which enabled its wide dissemination worldwide is its simplicity. A significant challenge in trying to characterize TBI more comprehensively will be implementation in routine clinical practice, across different healthcare systems, and

in settings with differing levels of resources and diverse patient demographics.

As we celebrate the 50th anniversary of the Glasgow Coma Scale, the GCS remains the bedrock of assessment of patients with TBI. The proposed multidimensional framework represents an opportunity to explore how our collective advancing knowledge about TBI might improve assessment in acute TBI and might herald a shift towards personalized, precision medicine, refining future clinical trial design and so help to improve outcomes for patients with TBI. It is hoped that this approach will facilitate advancements in the field over the next 50 years (Fig. 1).

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Declarations

Conflicts of interest
The authors do not have any conflicts of interest regarding this manuscript.

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References

1. Teasdale G, Jennett B (1974) Assessment of coma and impaired consciousness. A practical scale. Lancet 2(7872):81–84
2. Teasdale G, Maas A, Lecky F, Manley G, Stocchetti N, Murray G (2014) The Glasgow Coma Scale at 40 years: standing the test of time. Lancet Neurol 13(8):844–854
3. Reith FC, Brennan PM, Maas AI, Teasdale GM (2016) Lack of standardization in the use of the Glasgow Coma Scale: results of international surveys. J Neurotrauma 33(1):89–94
4. Bodien YG, Barra A, Temkin NR, Barber J, Foreman B, Vassar M et al (2021) Diagnosing level of consciousness: the limits of the Glasgow Coma Scale total score. J Neurotrauma 38(23):3295–3305
5. Steyerberg EW, Mushkudiani N, Perel P, Butcher I, Lu J, McHugh GS et al (2008) Predicting outcome after traumatic brain injury: development and international validation of prognostic scores based on admission characteristics. PLoS Med 5(8):e165
6. Jennett B, Teasdale G, Galbraith S, Pickard J, Grant H, Braakman R et al (1977) Severe head injuries in three countries. J Neurol Neurosurg Psychiatry 40(3):291–298
7. Rimel RW, Giordani B, Barth JT, Boll TJ, Jane JA (1981) Disability caused by minor head injury. Neurosurgery 9(3):221–228
8. Rimel RW, Giordani B, Barth JT, Jane JA (1982) Moderate head injury: completing the clinical spectrum of brain trauma. Neurosurgery 11(3):344–351
9. Nelson LD, Temkin NR, Dikmen S, Barber J, Giacino JT, Yuh E et al (2019) Recovery after mild traumatic brain injury in patients presenting to US level I trauma centers: a transforming research and clinical knowledge in traumatic brain injury (TRACK-TBI) study. JAMA Neurol 76(9):1049–1059
10. Ganti L, Stead T, Daneshvar Y, Bodhit AN, Pulvino C, Ayala SW, Peters KR (2019) GCS 15: when mild TBI isn't so mild. Neurol Res Pract 1:6
11. Maas AIR, Menon DK, Manley GT, Abrams M, Akerlund C, Andelic N et al (2022) Traumatic brain injury: progress and challenges in prevention, clinical care, and research. Lancet Neurol 21(11):1004–1060
12 Schey JE, Schoch M, Kerr D (2024) The predictive validity of the full outline of unresponsiveness score compared to the Glasgow Coma Scale in the intensive care unit: a systematic review. Neurocrit Care. https://doi.org/10.1007/s12028-024-02150-8
13 Murray GD, Brennan PM, Teasdale GM (2018) Simplifying the use of prognostic information in traumatic brain injury. Part 2: graphical presentation of probabilities. J Neurosurg 128(6):1621–1634
14. Manley GT, Maas AI (2024) The Glasgow Coma Scale at 50: looking back and forward. Lancet 404(10454):734–735